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FORESTS AND FUELWOOD USE IN NOVA SCOTIA

AN OVERVIEW AND MONITORING APPROACH

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ABSTRACT

The School for Resource and Environmental Studies has conducted research, for several years, in the areas of residential wood fuel use and forest management in Nova Scotia. This report presents an integrated overview of that research and develops recommendations and conclusions.

The use of residential wood fuel has been increasing steadily since the late 1970's, for a variety of reasons, chiefly the rising price of home heating oil and electricity, coupled with government incentive programs to convert homes from oil heating. Surveys have shown distinct patterns of use that differ between urban, rural and small-town residents. The most significant aspects of these patterns are outlined, historical trends of usage are examined, and recommendations are made for improving the marketing and supply of fuel wood.

The increased use of residential wood fuel, coupled with a growing interest in forestry waste biomass for heating, raises a number of questions regarding both the socio-economic dimension of forest management (e.g. the costs and benefits of wood fuel use; hardwood to softwood production conversion; structural barriers to increased use) and the environmental dimension (e.g. nutrient leaching due to whole tree harvesting; wildlife habitat loss). A related topic that is also considered is the potential for air pollution from wood burning devices.

Nova Scotia residents, particularly in rural areas, have made a substantial committment to the burning of wood as a fuel. A central recommendation of the report is that a comprehensive and well-designed survey of residential wood fuel use in Nova Scotia is necessary, in order to provide accurate data over a long time period, for use in policy development and planning for residential wood fuel use in the Province.

1 INTRODUCTION

This paper serves as an introduction to and overview of, wood fuel use and forestry management in Nova Scotia, based on research conducted by the School for Resource and Environmental Studies (SRES), Dalhousie University. SRES, formerly the Institute for Resource and Environmental Studies (IRES), has been conducting research in the areas of woodfuel use and forest management in Nova Scotia, since 1980.

The research at SRES has four main areas of focus:

1. The energy potential of Nova Scotia's hardwoods (Henry, 1981; Henry et al., 1982);
2. Environmental considerations of intensive forest management (Freedman, 1982);
3. Residential wood fuel supply and consumption in urban, small-town and rural areas of Nova Scotia (Hanson et al., 1980; Blair, 1981; Blair and Hanson, 1981; Murphy et al., 1981; Gray and Blair, 1984; Gray and Blair, 1985); and
4. Development of a methodology for a residential woodfuel use monitoring program for Nova Scotia.

Nova Scotia is unique among Canadian provinces in that its forest land is largely in private hands, and the majority is in small freeholdings*. This situation presents a challenge to management of the Province's forests. Severe problems of wood supply are currently facing the forest industry in Atlantic Canada, particularly for softwood. In Nova Scotia, however, there is currently a surplus in the hardwood resource of low quality merchantable biomass.

In this context, SRES research has shown an increasing use of wood for fuel in Nova Scotia households since the late 1970's, particularly in rural areas. This trend is confirmed by data from Statistics Canada (Statistics Canada, 1985). It is assumed to be primarily a result of rising prices for both home heating oil and electricity.

Urban, small-town and rural residential users of woodfuel have been surveyed by SRES. **While substantial, and increasing, use of woodfuel was shown in all three groups, there were significant differences between the groups**. Rural residents were more likely to depend on wood as a heating source than either small-town or urban residents. Small-town residents were in turn heavier users than urban residents. Recreational burning of wood (for pleasure, in a fireplace) was most popular among urban households. These differing patterns of use have implications for the supply and marketing of woodfuel, which are outlined further in Section 3.

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* While this is also true of Prince Edward Island, most of the land in that province is used for agricultural, not forestry purposes.

Increased use of woodfuel for residential use and wood biomass energy for commercial use could lead to more intensive forest management practices. The environmental considerations of more intensive use have been investigated at SRES (Freedman 1982) and are outlined in this paper (Section 4). The potential environmental impacts from air pollution from wood burning devices are discussed in Section 5.

There have been a number of recent initiatives undertaken in the areas of forest management and use of wood for fuel. The most important of these - most notably the report of the Royal Commission on Forestry, the Nova Scotia House of Assembly Select Committee on Energy from Wood Biomass, and the increased interest in wood residues for heating - are discussed in Section 6.

In light of the substantial use of woodfuel for residential heating in Nova Scotia, it is important, in terms of policy planning and resource management, to have a program for gathering data on woodfuel use, which is both comprehensive and consistent, and thus allows for development of a time series. To this end, a methodology for conducting such a program has been developed by SRES (Section 7).

2 Forest Management and Woodfuel Availability

The forests of Nova Scotia cover approximately 4.2 million hectares, of which 4 million is unreserved (i.e. forest land that by law or policy is available for the harvesting of forest crops). Eighty-nine percent (3.6 million ha) of this area is classified as productive, i.e. capable of producing a merchantable stand within a reasonable length of time. The cover class distribution is almost half softwood (43%), with 26% mixed wood, 17% hardwood and 13% undetermined (Bonnor, 1986).

In addition, 71% of the total forested land is privately owned, with 52% in small freeholdings (<= 400 ha) (Henry, 1981a). Twenty-six percent is provincial crown land, while 3% is federal land. The large number of small private woodlots is a condition unique to Nova Scotia among the Canadian provinces, and presents a challenge to large-area forest management.

The forests have been exploited by European settlers for at least 300 years, throughout which there has been a general lack of forest management. During the early years of sawmilling - and especially during the shipbuilding boom of the mid-1800's - highgrading (cutting only the best logs) was a general practice. With the beginning of

the pulp and paper industry (ca. 1900), clearcutting became the predominant harvesting method (Goldsmith, 1980). Unless conducted properly, clearcutting can have deleterious effects on some sites (e.g. increased erosion, leaching of soil nutrients, etc.). The lack of good forest management throughout the period of exploitation has left the forest resource in a state of poor quality and with low growth relative to potential. The need for better forest management was voiced as early as 1912, and has been reiterated many times since (Henry et al., 1982). The most recent has come from the Royal Commission on Forestry in 1984.

The forest industries are a very large economic sector in Atlantic Canada, accounting for 27.3% of the totai value added in manufacturing, and directly employing about 25,600 people. Each year about 27,000 ha of mature forest are harvested in the region, mainly by clear-cutting. This is the most significant anthropogenic source of disturbance of natural terrestrial ecosystems in the region, in terms of site disturbance, impacts on wildlife, recreation, and other forest uses. However, in spite of the scale of disturbance of natural areas, remarkably little research has examined the significance of the environmental impacts of these activities, and particularly the longer-term effects.

Severe problems of wood supply are currently facing the forest industry in Atlantic Canada. These problems have emerged for a number of reasons, including limited forest management in the past, inadequate regeneration on many cut-over or burned sites, withdrawals of forests for non-exploitive (e.g., parks or game reserves), and spruce budworm depredations. The latter may eventually result in the loss of some 5 x 10 6 ha of mature fir-spruce forest, an area that is equivalent to about 10 years of harvest by forest industries. Industry and government response to this shortage of wood will include intensified programs of forest management, involving some combination of more complete utilization of the forest, exploitation of remote stands, improved protection against fire, insects, and disease, more extensive and intensive silviculture, and major programs of reforestation and conversion of hardwoods and mixed woods to conifer stands.

Wood as Fuel - General Considerations

Nova Scotia depends on oil, although this dependence has been lessened in recent years. Sixty-five percent of the energy used in the province (Woolaver, N.S. Mines and Energy, pers. com., 1985 figure) is produced from imported foreign oil (down from 80% in 1979). Forty-three per cent of the electrical generating capacity comes from oil burning units, (Statistics Canada, December, 1984) down from 65% in 1979. In addition, oil is used directly to heat 68% of the homes in Nova Scotia (Statistics Canada, May, 1985) down from 85% in 1979 (Mines and Energy 1979). It is estimated (Henry et al., 1982) that Nova Scotia could reduce its dependence on foreign imported oil by

increasing the harvest of surplus hardwood volume and using the low quality wood as fuel for domestic heating. Softwood is not really an option as the annual allowable cut (AAC) of softwood is being exceeded by 10-20% (ibid.); therefore, only the mill and forest wastes of the softwood component are available for energy production. (Greater use of softwoods, including pulpwood quality softwood, would be determined by the cost of woodfuel and the price of heating oil.) On the other hand, the hardwood forests are underutilized by as much as 60% of their AAC. Thus, there is considerable potential to increase the harvest of hardwoods for fuelwood. This current surplus of ca. 180,000 cords/year could be used to replace 15% of the home heating oil.

The price of the net energy, on a province wide basis, available from wood compares favourably with that from oil. In rural areas of the province the price of wood relative to oil is significantly less. Present value analysis showed that a wood-fired homeheating system is less expensive, in most cases, than a comparable oil-fired system. An average home could save as much as $10,000 over 20 years by investing in wood heat. An increased hardwood harvest could generate at least $3.6 million/year of income and using wood heat would improve the Province's balance of payments (Henry, 1981b). The increased harvesting would also provide economic stimulus for more intensive forest management and thus increased yields, values of forest products and employment in the rural economy.

The current hardwood resource of Nova Scotia has a surplus of low quality merchantable biomass of about $8.0 \times 10^5 m^3\ year^{-1}$. This surplus could range from 0.13 to $1.77 \times 10^6\ m^3\ year^{-1}$ once projected hardwood demands of the forest industries are accounted for, and if some assumptions used in annual allowable cut calculations are altered (Henry et al., 1982). Using this excess hardwood biomass for energy production would provide a market for this low quality wood, provide economic incentives for better management of the hardwood forest and have various environmental, social and economic benefits throughout the province. The surplus hardwood volumes in Nova Scotia could be used in a variety of wood energy processes. Five wood energy processes were investigated (Table 1), including: (i) residential heating; (ii) methanol production; (iii) wood fuel in the pulp and paper industry; (iv) wood-fired thermal electrical generation and (v) electrical generation from wood-gas/diesel fuel engines. Table 2 describes a wood energy mix of residential heating, fuelwood in the pulp and paper industry and wood-based methanol production which was developed to show what the authors believe to be a feasible wood energy development scenario for the next 10 to 20 years. Under the conditions of this mix, a total of 1.0 to 1.2×10^6 m3 year-1 of hardwood could be used by the year 1990. This could provide between 755 and 840 jobs and generate $17.0 to 19.0 million throughout the regional economy of Nova Scotia.

This analysis, of course was conducted before the recent drop in world-oil prices. This is not to detract from the basic conclusions reached, merely to point out that the saving may not be as much as originally indicated. As well, oil prices could begin to rise again.

Table 1

Summary of potential wood volumes (and per cent of current surplus hardwood AAC) required, oil savings, net oil savings, number of jobs created, direct income and regional economic impacts of the five wood energy process investigated. (From: Henry et al., 1982.)

	Residential heating	Methanol production[1]	Industrial application (pulp & paper)	Wood-fired electrical generation[2] A	Wood-fired electrical generation[2] B
Potential volume of wood required (10^3 m^3 $year^{-1}$)	800	167	700	193	795
Percent of surplus hardwood AAC	100	23.4	87.5	24.1	99.3
Oil savings (10^6 litres $year^{-1}$)[3]	142.5a	131b	110c	70c	290c
Net oil $ savings (10^6 $)[4]	10.0	15.6d	7.5	8.3	34.4
Potential number of jobs[5]	334e	420	292	83	200
Direct income (10^6 $)[6]	5.0	6.9	4.4	1.25	3.0
Regional economic impacts (10^6 $)[7]	7.5	10.35	6.6	1.88	4.5

1 227.3 x 10^6 litres year natural gas hybrid plant, requires 0.57 m^3 natural gas per litre of methanol

2 A - 25 MW thermal generating plant producing 17.5 x 108 kWh $year^{-1}$; B - five 20 MW gasification/dual-fuel generators.

3 a- Light fuel oil ($0.19 $litre^{-1}$); b - crude oil ($38 bbl^{-1}); c - heavy fuel oil ($0.16 $litre^{-1}$)

4 Oil $ savings minus wood costs; d - includes wood and natural gas costs ($0.212 m^{-3}; 1980 Canadian dollars).

5 e - Potential jobs in harvesting and preparing fuelwood only; assumes 1.1 person hours m^{-3}.

6 Average annual income = $15,000 (1980 Canadian dollars).

7 Economic multiplier = 1.5; 1980 Canadian dollars.

Table 2
Potential hardwood use, number of jobs and socio-economic impacts of the proposed wood energy mix by 1990
(From: Henry et al., 1982.)

	Hardwood Use (10^6 m^3 $year^{-1}$)	Potential number of jobs	Regional economic impacts (10^6 1980$)[5]
Residential heating	0.51	2104	4.73
Pulp and paper industry	0.3-0.52	125-2104	2.83-4.73
Methanol production[3]	0.19	420	9.45
Total	1.0-1.2	755-840	17.0-18.91

1 Theoretical demand projection.

2 Assumes industry replaces 50-80% of the oil-derived energy.

3 A 227.3 x 10^6 litres $year^{-1}$ plant using a natural gas hybrid process; replacing current total gasoline consumption with 15% methanol/gasoline blend.

4 Assumes 1.1 person-hours to harvest and prepare a cubic metre of fuelwood.

5 Assumes an average annual income per job of $15,000 and a regional economic multiplier of 1.5.

One assumption on which this analysis rests is that natural gas is available for the methanol plant. At the time of writing (1892), this was estimated to be 1983-84. It is now not foreseen for the immediate future.

Increasing the hardwood harvest in Nova Scotia for fuelwood will have benefits for forest management. Much of the current hardwood resource is of poor merchantable quality which accounts for the low level of industrial hardwood production in Nova Scotia. Fuelwood would provide a new market for the excess low quality hardwood and an economic stimulus for more intensive forest management. Management schemes could be implemented where the thinnings, cleanings, etc. from silvicultural operations could be sold for fuelwood to offset their costs (although this may result in nutrient loss on the sites). Under better forest management, the productivity and quality of the hardwood forest would increase with a concomitant increase in the value of products derived from the forest resource. Also, the employment generated through more intensive forest management would be a boost to the rural economy of Nova Scotia.

The forest resource has potential to supply some of Nova Scotia's renewable energy needs, and will help to reduce the dependence on imported oil. However, fuelwood supply problems could develop because of the land ownership pattern, and other environmental and socio-economic constraints. Some of these issues were investigated by the Nova Scotia Legislature Select Committee on Forestry Biomass. One of the ways to expedite conversion to woodfuel is to improve the wood fuel supply infrastructure; measures to accomplish this are considered in the following section.

Using the surplus low quality hardwoods for energy production will help provide the necessary economic incentives for better forest management throughout the hardwood forests. Forest management, in turn, will increase the quantity and quality of the hardwood resource and further increase the environmental, social and economic benefits derived from this renewable resource.

3 Residential Woodfuel Supply, Marketing and Consumption:

A number of studies have been conducted at SRES dealing with the supply, marketing and consumption of fuel wood for residential use in urban, small-town and rural areas of Nova Scotia.

Woodfuel Supply and Marketing:

Domestic fuelwood and supply for urban Nova Scotia

Hanson et al., (1980) found that fuelwood demand is on the increase in Nova Scotia, while supply is constrained by competing uses for hardwood, especially on Crown Lands; reluctance of woodlot owners to release surplus hardwood; and inadequate marketing. Potentially there is sufficient surplus to supply more than 25% of the Province's residential heating from wood. Such a use can be economically justified at least in rural areas. Consumer demand in urban areas such as Halifax/Dartmouth is poorly understood. There are few full-time vendors. Problems of supply exist for both dealers and consumers. At present, there is no comprehensive provincial policy to encourage hardwood management for fuelwood and few incentives for responsible cutting of the existing hardwood surplus. Policy recommendations were suggested for improved resource availability, woodlot management for fuelwood and urban marketing.

One hundred personal interviews were conducted (79 woodlot owners; 21 others: fuelwood dealers, woodstove store owners, "policy makers", potential woodyard

operators). Of the woodlot owners interviewed, only 37% were selling fuelwood. Vendors could be divided into those selling less than 30 cords per year (15%), generally locally to friends and family, and those who sold larger volumes (22%) and therefore had to take into account inputs such as equipment and labour and, of course, marketing considerations. With 63% of the woodlot owners interviewed not selling fuelwood, there might appear to be considerable potential for expanding the number of suppliers. However, at the time of the survey, only 16% of this 63% were thinking about becoming vendors.

While most woodlot owners interviewed were uninterested in selling fuelwood, they were definitely interested in using their own wood for home heating. Seventy-seven percent of the interviewed owners burned wood for home heating, falling into these patterns:

As sole source of domestic heating	22%
As primary source of heat	33%
As supplementary source	22%
TOTAL	77%

The authors made a number of policy recommendations, based on their findings:

1. **Hardwood Allocation for Fuelwood**
   A policy for use and management of the Province's hardwood resource on both Crown and private lands, must be developed as soon as possible.

2. **Sustainable Hardwood Yields**
   As part of the above policy, there should be protection of desirable future levels of the hardwood resource and realistic plans for how these yield objectives may be met.

3. **Woodlot Management Plans**
   Assuming that private woodlots will play the major role in fuelwood supply, special attention should be given to this use in management plans developed under the Nova Scotia-Canada Forestry Subsidiary Agreement.

4. **Monitoring Resource Availability**
   Before embarking on potentially costly support programs for woodlot operations or marketing, and during implementation of any such programs, there should be a field study of likely impacts and participation.

5. **Information and Incentive Programs for Woodlot Owners**
   Woodlot owners need to be familiarized with demand for fuelwood.

7. **Fuelwood Specialist**

The Nova Scotia Department of Lands and Forests should create the position of Fuelwood Specialist for Nova Scotia.

8. **Protection for Urban Fuelwood Users**

The urban homeowner has a legitimate and growing demand for wood. These homeowners are the most vulnerable of all fuelwood users to fluctuations in supply. On-going surveys of supply and demand are therefore necessary.

Urban markets need to be organized through moderate regulation and incentives for wood suppliers:

a. Some form of identification for wood dealers.

b. Consumers and wood dealers alike should be provided with standard definitions of terms.

c. Financial assistance to aid in the establishment of fuelwood yards near cities should be considered.

d. Once a better profile is available of urban consumer demand, consideration should be given to assist in establishment of more advanced services.

The authors felt that it was important action be taken quickly, while good avenues still exist for increasing both short-term and long-term supply. As the problems of wood fuel supply and demand are understudied, effort should be taken to provide a better data base. But there are still enough indicators to provide an initial set of recommendations for government and private sector action. The recommendations of the study, they felt, could all be implemented reasonably quickly. They would substantially influence how hardwood resources are perceived within the province, as well as help to improve fuelwood availability.

Woodlot owners in N.S. and the use of fuelwood

A study of woodlot owners in Nova Scotia was undertaken by Blair (1981). She found that the demand for fuelwood was increasing in Nova Scotia. Since the provincial government cannot assure a sustained supply of fuelwood from Crown Land, much of the fuelwood must come from the 73% of the forested land in private ownership (52% in holdings of less than 1,000 acres). Woodlot owners within a 100 km radius of Halifax/Dartmouth were interviewed. The importance of their woodlot to their household income, as well as their personal use of fuelwood and interest in selling fuelwood, was investigated. Recommendations, based on interviews with woodlot owners as well as persons active in the marketing of fuelwood and policy affecting fuelwood, were presented to facilitate organization of the fuelwood market within Nova Scotia.

The major recommendations of the study were:

1. **Protection**

   Identification and/or licencing should be available for fuelwood dealers. This certification would provide protection for the consumer and the dealer.

2. **Education, Public Awareness**

   a. Supply

   Woodlot owners should be familiarized with the demand for fuelwood, principally with the use of television ads. Simultaneously, the importance of sustained yield fuelwood operations must be emphasized.

   b. Marketing

   Consumers and fuelwood dealers should be educated through the use of television ads and brochures. Some of the issues which require clarification are:

   i. definition of a cord
   ii. terms common to fuelwood use
   iii. the value of softwood as a fuel
   iv. the value of buying green wood.

3. **Funding and Supplying Fuelwood Businesses**

   Funding for fuelwood businesses must be made more available. Financial assistance for promising entrepreneurs should be available through existing government programs.

4. **Enforcement - A Last Resort**

   a. Management

   The Forest Practices Improvement Board should incorporate a regulation in the Forest Improvement Act to allow prosecution for irresponsible harvest of hardwood (i.e. defined as harvest which neglects future sustained yield).

   b. Theft

   The penalty for wood theft is not sufficient to act as a deterrent. The resource is being undervalued and woodlot owners are not protected.

Guaranteed access to wood supply is essential for continued conversion to wood burning. Particularly in the urban and urban fringe areas, homeowners must rely on purchased supplies of wood. Because of the large number of small private woodlot owners in Nova Scotia, recommendations such as the above would facilitate the orderly matching of supply and demand.

Urban fuelwood dealers in Halifax/Dartmouth

Murphy et al., (1981) interviewed 43 urban fuelwood dealers who advertised in newspapers or were identified from other sources. The majority were small scale,

relatively new to the business of wood vending, and engaged in wood dealing as a secondary occupation or hobby. Most employed simple technology to handle wood. A variety of wood products (including 8' lengths, slabwood and split stovewood) were available from these dealers.

Wood supply sources were very diverse, but some were being seriously constrained because of restrictions on pulp land cutting. One-third to one-half of the dealers were planning to leave the business. A significant minority had become well established although almost all of them were selling less than 100 cords a year. Limited wood supply was certainly not the only reason for the relatively low level of sales on the part of many dealers - most are occupational pluralists, with modest investments of time and equipment.

Marketing practices were found to be very disorganized. Regular delivery by contract was the exception rather than the rule. There was wide price variation for similar products. Product quality control is almost non-existent. Approximately two-thirds of the dealers favoured certification of loads of wood and the establishment of an agency to handle dealer and consumer complaints.

The authors concluded that in the absence of policies explicitly designed to facilitate fuelwood supply and marketing, it is very difficult to imagine that economically efficient dealership operations would be the norm. One approach to solving continuity of supply and quality problems would be the establishment of one or more wood yards in the Halifax/Dartmouth area. Almost half of the dealers were prepared to sell directly to such a yard.

As well, the means to encourage wood dealerships must include sources of information on how to establish this type of small business, certification of their performance, a mechanism for proper advertising of their products and prices, and finally, better guarantee of access to hardwood resources.

As a final note, it is well to remember that the sample of wood dealers in the above survey was restricted mainly to those who advertise. Blair (1981) found that most woodlot owners selling to customers do not advertise. The sample could thus be considered as biased toward "traditional" dealers who would have more stable relationships with customers and quite likely would have different characteristics and opinions than less well established dealers.

Fuelwood Consumers:

Surveys of residential fuelwood consumers were undertaken by SRES, of urban consumers (Blair and Hanson, 1981); small-town consumers (Blair and Hanson, 1982; Gray and Blair, 1984); and rural consumers (Gray and Blair, 1985). The studies provide for interesting contrasts in the woodburning patterns of these groups of residents.

Urban Consumers (Blair and Hanson, 1981):

Questionnaires asking for detailed information of fuelwood use were mailed to 2,000 households (excluding those households located in apartment buildings) in the Halifax/Dartmouth area. Almost 40% of the households of respondents were burning some wood for fuel, most in fireplaces only. The 1980 consumption of fuelwood in Halifax/Dartmouth was estimated at 18,000 to 19,000 cords. The consumption (based on survey responses) has increased approximately 3,000 cords each year from 1978 to 1980. Based on a simple linear extrapolation of trends from this time period, the projected level of fuelwood use by 1985 was 33,000 cords. Whether the drop in the price of oil, only marginally reflected in the cost of heating oil, has been a factor, is not known.

Over 30% of the burners started burning wood during the five years previous to the survey. The desire to save money was not a major reason for starting; only 12% of the burners said they started to burn wood for economic reasons. Thirty-nine percent said they did so for recreation (i.e. enjoyment); 22% that they liked wood heat (e.g. the moisture content). Private dealers supplied over 70% of the volume of the wood burned in 1980, compared with 10% of the volume which burners acquired from their own woodlot. Also, despite popularized acounts of dealer shortcomings, there was no overwhelming evidence of dissatisfaction with private dealers.

The preferred fuelwood was dry, cut, split and delivered hardwood. The preferences for processed wood, coupled with respondents' desire for a list of dealers, and support of wood yards and wood co-ops, are justification for entrepreneurial initiatives, such as the establishment of city wood yards. Such yards would be suitable and are a possible means of providing for the projected growth in consumption. As of 1986, to our knowledge, no such yards have been established.

The Sackville Study (Gray and Blair, 1984):

In 1984, SRES was contracted by the Environmental Protection Service, Environment Canada, to determine the extent and nature of residential woodfuel use in Lower Sackville, Halifax County, N.S. Lower Sackville was selected as the site of this survey, based on the relatively large number of complaints received from this area regarding smoke pollution from wood burning, by EPS and the Nova Scotia Department of the

Environment, over the past several years. (See Section 6 for a discussion of pollution from residential woodfuel burning.)

The results showed considerable wood burning in the Sackville area surveyed - 46% of households. Relatively few (7%) households relied on wood as a primary source of heating, however, one-quarter used wood as their supplementary heating source. While those burning wood as a primary source burned more per household (4.0 versus 1.8 cords in the previous year), the amount of hardwood burned as a primary source of heat (955 cords or 29%) was less than the total burned as a supplementary source (1,975 cords, or 60%). In addition, another 18% of households burned some wood, mostly in a fireplace, for recreation. The estimate for this latter category of burner is 362 cords (11% of the hardwood burned).

One possible source of error in estimating fuelwood consumption is the various definitions for a "cord of wood". In addition there is potential error for those burning small amounts of wood in a fireplace for recreation; these respondents often stated they didn't know how much, but it was "less than a cord". The amount of this error was very difficult to estimate.

Most of the wood burned was hardwood (3,292 cords versus only 169 cords of softwood). Most was in dry form (64%, or 2,230 cords). It is noteworthy that most of the wood was burned in air-tight stoves (60% or 2,065 cords), followed by the combination furnace with 15%. Fireplace was the third most significant device (13%).These three devices accounted for 88% of the wood burned in the area.

Small-town Consumers (Blair and Hanson,1982):

The results of a 1981 survey showed burners in Yarmouth primarily used wood to save money, in contrast to the situation in Halifax/Dartmouth. The majority were using wood as a supplementary source of energy. Twenty-two percent said that oil and wood were both the main fuels. The overall consumption of wood in the community reflected the supplemental nature of this usage. Almost half of the burners (49%) used less than two cords of fuelwood in 1980. Private dealers supplied many of the Yarmouth burners (63%). The preferred product was cut, split, delivered, hardwood. Since satisfaction with their purchased wood was, in general, moderate, and 44% said they did not have a list of dealers but would like to have one, there was evidence that organization of the fuelwood industry within the community would be positively received.

Burners in Middleton varied in their fuelwood use patterns from those in Yarmouth. There was more reliance on wood as a primary fuel in Middleton. Fifteen percent of the Middleton burners said they used wood as their sole energy source. Saving money was again a primary motive, but many Middleton burners said that their preference for wood heat was also a major factor in their choosing wood as a fuel. Fifty-six percent burned

over two cords in 1980. Private dealers played a much less significant role as fuelwood suppliers in Middleton than in Yarmouth. Only 33% of the Middleton burners reported a private dealer as their main source of fuelwood. Most of the remainder got wood from private woodlots, i.e. their own, family or friends', and 11% got wood from The Nova Scotia Department of Lands and Forests (compared to 3% in Yarmouth). Also, while, cut, split, delivered, hardwood was popular in the community, almost half (48%) said they would prefer delivered, seasoned, hardwood in 8' or 4' lengths. This preference is largely the result of a relatively high percentage of burners having equipment to cut wood (63%), and to a lesser degree, equipment to transport wood. As with Yarmouth, there was evidence to suggest that organization of the fuelwood market within the community would be appreciated.

Rural Consumers (Gray and Blair, 1985):

Rural Colchester County residents, chosen in a random sample, were surveyed in 1985. Over half (52%) of the respondents used wood as a primary heat source. In total, three-quarters were burning some wood. Few (4%) households surveyed burned wood for recreation. Three–quarters of the rural burners gave "saving money" as a reason for burning wood, either as the sole reason, or in combination with others.

Most woodburners burnt their wood in sophisticated devices - air-tight stoves and wood furnaces (both over 35%), or combination (e.g. wood and oil) furnaces (18%). The fireplace was used by less than 10% of the woodburners.

The average amount of wood burnt per household in 1983 was 4.9 cords. The weighted total estimate for the county was 22,821 cords burnt. Thirty-one percent obtained their wood from their own woodlot, 24% from a dealer, and 23% from a friend or relative. There was little or no problem reported with the supply of wood. Over 95% of respondents indicated they were able to get all the wood they wanted. The weighted total estimate of shortage was only 38 cords.

It appears that rural Nova Scotia residents, at least in Colchester County, have made a substantial commitment to the burning of wood as a fuel.

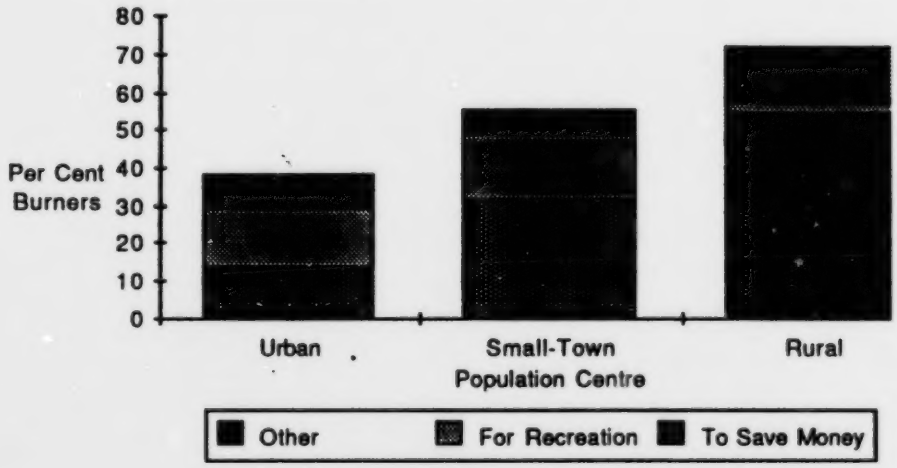
Consumer Studies - Some Comparisons and Conclusions

The general picture that emerged from the rural Colchester County survey was one of woodfuel as an important, pervasive and stable source of heating in the rural areas of Colchester County. Nearly three–quarters of the rural households used wood as a primary or secondary source of heat. This was a higher percentage than either urban residents (Halifax/Dartmouth) where the percentage was 37%, or small-town residents

(Yarmouth/Middleton) where the percentage was 44-46% (Blair and Hanson 1981;1982). Part of this difference may be explained by a general increase in the use of woodfuel since the earlier surveys were conducted, but it is assumed that a large proportion of the difference is due to the widespread and traditional use of woodfuel in rural areas, where people either own or live near woodlots.

While few (4%) woodburners surveyed in rural Colchester County burnt wood for recreation, the corresponding figures were 18% for Yarmouth/Middleton, and 43% for Halifax/Dartmouth. A graphic representation of the percentage of households burning wood (as a primary or secondary source of heat) in rural, small town and urban areas, and their reasons, is shown in Figure 1.

Figure 1 Reasons for Burning Wood



Source: S.R.E.S. Surveys

Note: The category of "Other" comprises a variety of reasons, with the primary one for all three groups being "Like wood heat". The reason of "For extra heat" was cited by both urban and small-town residents, while accessibility to wood was reported by some rural residents.

Most rural residents burnt their wood in sophisticated devices such as air-tight stoves and wood furnaces (both over 35%), while the fireplace was used by less than 10% of burners. In contrast, 74% of urban woodburners reported using fireplaces, and only 22% air-tight wood stoves (Blair and Hanson, 1981). Fireplaces were also the most

popular devices in small towns: 41% in Yarmouth and 52% in Middleton, followed by air-tight stoves at 25% (Blair and Hanson, 1982).

The largest single source of wood for rural Colchester County residents was their own woodlot, with only about one-quarter obtaining wood from a dealer. By contrast, 63% of burners in Yarmouth bought wood from private dealers, 33% in Middleton. Only 6% in each community obtained wood from a personal woodlot (Blair and Hanson, 1982). While there was little or no shortage of wood reported by rural resudents, 16% of]Halifax/Dartmouth burners, 16% of Yarmouth burners and 11% of Middleton burners reported they had trouble maintaining their supply.

By comparing the two communities presented in the Yarmouth/Middleton study, and the Halifax/Dartmouth community studied in 1981 (Blair and Hanson), certain general statements about community fuelwood use in the context of the Provincial fuelwood industry can be made. First, fuelwood use profiles differ between communities. Information from one community cannot be directly applied to another community. Secondly, there are some common problems. Burners in all three communities studied are having problems maintaining their supplies of fuelwood. Marketing is not optimized. Burners often cannot acquire the fuelwood product they would prefer, and access to organized marketing, e.g. lists of dealers, wood co-ops, etc., is below market demand.

Recommendations were presented (Blair and Hanson, 1982), similar to those presented in earlier IRES fuelwood studies (Hanson, 1981; Murphy et al., 1981; Blair, 1981; Blair and Hanson, 1981), to further the development of the fuelwood industry in Nova Scotia. This development is based on the underlying premise of ensured, sustained supplies of fuelwood.

4 Environmental Considerations of Forest Management:

As mentioned previously, more intensive use of fuelwood will lead to more intensive forest management, and consequently intensified related impacts. An overview of these environmental impacts was conducted by Freedman (1982).

Erosion and nutrient loss

Major environmental impacts have occurred as a result of forestry activities in the Atlantic provinces. Erosion has occurred on many cutover watersheds, resulting in a degradation of water quality and fish habitat, loss of soil, and some loss of site nutrient capital, due to leaching or biomass removal. The effects of the latter are accelerated by the more intensive harvest techniques that are now coming into use in parts of the region, for example whole-tree clear-cutting. These various losses of nutrient capital

may be of significance on many sites, particularly if intensive, short-rotation harvests are used.

Wildlife habitats

Wildlife habitats can also be affected by forestry. However, the resulting changes are complex, depending on the initial conditions and the particular harvest techniques that are used. In general, the use of larger clear-cuts (e.g. > 10-15 ha) produces relatively greater effects than do smaller clear-cuts, particularly if the latter are spaced so as to produce a mosaic of habitat types representing a range of communities in the post-cutting secondary succession. Some economically important species of wildlife, such as white-tailed deer, moose, and snowshoe hare are benefited by some forest harvest practices, largely due to the production of larger quantities of higher quality browse.

Insecticides and herbicides

The impacts of the use of insecticides and herbicides in forestry are also of potential significance. The budworm spray programs have been largely successful in terms of keeping infested stands alive. However, they have also prolonged the current outbreak by providing a continued food source for the budworm. In addition, there has been significant public and some scientific controversy over the environmental impacts of the spray program, in terms of effects on terrestrial and aquatic non-target organisms, and on human health.

It seems likely that, as forest management intensifies in Atlantic Canada, there will be increases in the use of herbicides for silvicultural purposes in particular to encourage the growth of desirable softwood regeneration on cutover sites, by discouraging the growth of competing broadleaf vegetation. When practiced indiscriminately, hardwood which may be valuable for woodfuel and other uses could be taken out of production.

Softwood reforestation

The large–scale program of softwood reforestation in Atlantic Canada, (about 9,600 ha/year), may also have environmental consequences. Such effects would include changes in site hydrology, effects on nutrient cycling, possible contamination of water bodies by fertilizer nutrients, insecticides, and herbicides, and impacts on wildlife and species diversity. Softwood plantations, particularly if they are located on former hardwood sites, could increase the rate of acidification of soils and groundwater.

Ecologically significant areas

Though there is no comprehensive catalogue of ecologically significant areas or of rare or endangered species in Atlantic Canada, preliminary designations can be made on the basis of scattered published literature. Many of these ecologically significant areas can only be preserved if they are identified, and exempted from forestry operations, under recently proclaimed provincial legislative guidelines that presently exist, such as the Special Places Protection Act for Nova Scotia. A number of these sites are old-

growth forest stands. Economically, these stands are unproductive, as the dominant old trees prevent a vigourous growth of different age classes. Ecologically, however, these relic forests are priceless, containing a unique variety of plant and animal organisms (SRES, 1987).

Recreation

Recreation is an economically significant and legitimate use of forest lands, and it frequently can be accommodated with forestry in a multiple-use management scheme. The principal conflict between recreationists and forestry concerns visual impacts, but these can be softened by using smaller, less uniform clear-cuts, buffer strips, or less intensive harvesting techniques. In addition, opportunities for recreational hunting may be affected by some forestry activities which reduce the abundance of game animals, e.g. in situations where vigorous programs of hardwood brush suppression were pursued.

Short and long-term impacts

Many of the negative impacts of forestry that have been identified by Freedman (1982) are relatively short-term in nature, less than 5 years following the initial disturbance, while other impacts are of a longer–term nature. Examples of impacts that are usually short-term include effects on erosion of soils and streambanks, streamwater hydrology, leaching of nutrients, streamwater temperature, impacts of pesticides on non-target organisms, and some effects on the habitats of terrestrial wildlife. Longer–term impacts are associated with possible site impoverishment due to nutrient losses via harvested biomass or leaching, some effects on wildlife habitats which can only be reduced after secondary forest succession has occurred, possible site acidification, effects on wood supply, the loss of ecologically significant sites, and some recreational conflicts.

5 POLLUTION FROM RESIDENTIAL WOODFUEL COMBUSTION

Burning wood causes relatively little air pollution, of the type associated with fossil fuels, since the sulphur content of wood generated ranges from 0.01 to 0.05% and emissions of hydrocarbons and carbon monoxide are negligible in most cases. Emissions of particulates (ashes and liquid droplets containing acids, tars, etc.) are the most serious pollution problem associated with wood burning. Residential wood combustion emissions are almost entirely in the inhalable size range and contain toxic and carcinogenic pollutants, such as benzo(a)pyrene. Wood smoke could become a visual problem in areas with a high concentration of wood-burning appliances. On the other hand, unlike fossil fuels, burning wood will not necessarily contribute to the carbon dioxide (CO_2) buildup in the atmosphere. The amount of CO_2 fixed in a tree is released either when the tree dies and decays or when it is burned, and as long as an equivalent amount of wood regrows, the atmospheric CO_2 will remain in balance.

Based on studies of the impact of residential wood burning on urban air quality in Canada, and a noticeable increase in the number of complaints received by the Environmental Protection Service (EPS) Atlantic Regional Office and Nova Scotia provincial agencies, an investigation of the potential exposure for individuals as a result of residential woodfuel combustion was carried out in selected urban areas in the Atlantic Region. The School for Resource and Environmental Studies was contracted by the EPS Atlantic Regional Office to carry out field inspections. SRES also conducted a residential woodburning survey for Lower Sackville, and estimated wood stove use in Truro based on studies in other small urban centres in N.S. and rural Colchester County (Gray and Blair, 1984).

Initial sampling in February - April, 1984, showed that the levels of total suspended particulates (TSP) were quite low in both Truro and Lower Sackville. As well, levels of polynuclear aromatic hydrocarbons (PAH) were relatively low in comparsion to other areas (Kozak, 1985). These findings were considered somewhat surprising, considering that the SRES studies showed a substantial number of households burning wood (6.5% as a primary source, 25.0% supplementary and 17.8% for recreation) in the Lower Sackville area.

The low TSP concentrations were thought to be due to relatively warmer than normal winter and spring conditions in the Maritimes. Consequently, it was decided to conduct a second study in the Lower Sackville area in December, 1984 to March, 1985, to ensure that the low levels were not an anomaly.

Only TSP measures were taken. The results were almost double at one site (i.e. 39.8 $\mu g/m3$) in comparison to the previous study. One measurement of 122.9 $\mu g/m3$ was one of the highest ever recorded in the Halifax-Dartmouth metropolitan area since the air pollution monitoring was begun in the area. Depending on the specific day the

contribution may have been as high as 80 µg/m3 or so on a 24 hour basis, but generally was in the range of 10 - 20 µg/m3 (Kozak, 1985).

During the January/February, 1985 period there were a number of complaints regarding odour, respiratory difficulties, soiling and visibility problems, received from the Lower Sackville area. Most of the complaints were in the evenings. However, available PAH data does not suggest a public health impact from these materials, based on a lack of health significance attached to high levels measured in other areas (ibid.).

In the Atlantic Region, routine TSP monitoring will continue with special emphasis on provincial requests for assistance in areas of high residential wood combustion. Kozak concludes that results from existing studies suggest control efforts are required at a municipal level to reduce localized nuisance problems. Education on the proper use of woodstoves would appear to be the most appropriate immediate approach.

6 Recent Initiatives

There have been a number of recent initiatives affecting energy conservation, forest management, wood fuel use and biomass energy in Nova Scotia, since the SRES studies were conducted. The following is an outline of those that are particularly important.

Energy Conservation

The beginning of the 1980's saw an increasing emphasis on energy conservation, and the substitution of other sources of energy for oil, brought on in large part by the rising cost of oil. In October, 1980, the Federal Government, as part of the National Energy Program, began an off-oil substitution program - the Canada Oil Substitution Program (COSP). Under COSP, which ended in March, 1985, a taxable grant of up to $800 was given to homeowners and businesses that converted their furnaces from oil to another energy source. In Nova Scotia, over thirty-five thousand residential units were converted from oil, at a total cost for grants of $21.2 million dollars. Most of the conversions were to wood (91%), with 3% to propane, less than 1% to electricity, and 5% to other (solar, wind) (Energy, Mines and Resources, pers. comm.). There is no program of grant incentives at present.

A 1985 survey by Statistics Canada, reported that in Nova Scotia, seventy-three thousand homes (34%) had made recent (within the last three years) improvements for energy efficiency. Seventeen percent added insulation, 13% replaced or upgraded heating systems, and 17% reduced drafts. In spite of the recent drop in world oil prices,

energy conservation is likely to continue in Nova Scotia. The era of cheap energy seems to be over. Home heating oil prices have dropped with the drop in world oil prices, but are still above the levels of the early 1980's. Future increases are a distinct possibility. At the same time, such alternatives as electricity have increased in price in Nova Scotia.

Forest Management

In 1984, the Report of the Nova Scotia Royal Commission on Forestry was released. The Commission was established in 1982 to inquire into and make recommendations on the forest industry in Nova Scotia.

Forestry is Nova Scotia's largest resource-based industry, and seventy-five percent of the land base of the province is covered by trees. The total annual output of the industry is valued at over $500 million, with an average annual requirement of 3.3 million m^3 (1.5 million cords) of softwood fibre and 413,000 m^3 (200,000 cords) of hardwood fibre. Forest industries are major sources of employment and incomes, employing about 8,000 directly, and a further 16,000 indirectly.

Regarding the present state of the forest industry in N.S., the Commission stated:

> This resource has been diminished by highgrading, the ravages of fire, insects, diseases, weeds and wind, and the failure of society to make the best use of the remaining trees and to restore forest losses. In consequence, many forest-related jobs are in jeopardy and the environment is deteriorating.

Industry requirements can easily be satisfied in the short run and, in fact, because of under-capacity operations and an abundance of mature and overmature material, more than satisfied. But by approximately the year 2005, if current forest practices are maintained, there will not be enough raw material to meet the needs of industry in the seven eastern counties, on a sustained yield basis. Continuation of forest practices in Nova Scotia can only lead to an erosion of the resource, because an adequate long-term management policy is lacking.

The Commission recommended a Conservancy Program, including:

Conservancy - a program of forest restoration, conservation and improvement. Funds would be spent on scheduling, allocation, marketing, silviculture, and protection.

Sawlog forest - the cultivation of forest to generate the maximum amount of sawlog material, a pursuit which has its attractions because this product has a higher value than pulpwood.

Industrial biomass - Management of the forest to generate low grade fibre for biomass industries.

Species selection - The creation of policies and the pursuit of procedures to eliminate budworm-susceptible species, primarily balsam fir and white spruce.

The report was released to a storm of controversy. Small landholders were particularly critical of the recommendation that private woodlot owners enter into management plans, with a commitment from the landowner, his heirs and assigns, to follow the plan to completion. Those who did not participate would be taxed as speculative landholders. They were critical as well of a recommendation to strengthen the role of the Deputy Minister of Forestry.

Environmentalists opposed the recommendation that herbicides be recognized as a necessary and safe tool in forestry, as the Commission felt they they do not constitute a health hazard to those in direct or indirect contact. The Commission also recommended use of chemical over bacterial pesticides, sprayed by aerial means.

The Government was forced to state that punitive measures for woodlot owners not under a management plan would not be introduced. Only selected portions of the Commission's recommendations were to be implemented.

In 1986, a new forest policy was introduced by the Nova Scotia government. The approach appeared to have more emphasis on voluntary action by landlowners than did the Royal Commission Report:

> The Government of Nova Scotia is convinced that cooperation, supported by education, extension services and incentive assistance programs, is a more effective approach to better forest management than punitive taxation, legislation or regulation.

A distinct emphasis was placed on private lands and landowners. A primary thrust of the new policy is to encourage and assist private landlowners to make the best possible use of their forested lands.

Some mention was made in the policy of the use of wood for energy. In particular, a policy goal is:

> Seeking **new uses** for the hardwood species in particular and stimulating the further development of **harvesting residues and waste wood for energy** purposes. (emphasis in original.)

Forest Biomass Energy

Forest biomass may be defined as the mass of the above–ground portion of live trees. The first biomass survey of forest in Canada was released in 1986 (Bonnor 1986). In this report, the quantity of forest biomass available for energy purposes is defined as the nonmerchantable portion (bark, top, stumps, branches, foliage) of merchantable size trees growing on productive, accessible forest land. Productive land is defined as forest land that is capable of producing a merchantable stand within a reasonable length of time. Biomass is expressed in oven dry tonnes (ODT). The figures given for Nova Scotia (with a ±5% error margin) are:

ODT (million)	Petajoules
144.33	2,967

The amount of energy or heat that can be extracted from forest biomass does not vary much among species groups or components (wood or bark). The values cluster around 20 petajoules per million oven dry tonnes (Bonnor 1986). A rough rule of thumb is that a petajoule is enough energy to heat 7,000 houses for one year.

While these grand totals are base figures, they are obviously unrealistic in terms of actual utilization. A rough calculation of sustained yield, assuming a rotation age of 80 years (ibid.), yields:

ODT (million)	Petajoules
3.61	74

This energy is equivalent to 47% (in contrast to the present 8%) of the total Nova Scotia energy requirements of 156 petajoules (Mines and Energy,1985 figures), or enough energy to heat 518,000 houses for one year. It is also equivalent to 11.4 million barrels of oil, with an import substitution value of around $177 million at current oil prices ($14-$17 Canadian bbl). These figures are somewhat more optimistic than those of the Nova Scotia Select Committee on Biomass, discussed later in this paper. Their lower estimate is the result of calculations which took into account such factors as protection, silviculture, and losses to insects. As well, the biomass inventory estimate does not consider the size of woodlots. In Nova Scotia, many are relatively small, and a comercially viable, sustained yield operation may not be possible (MacQuarrie pers. comm.). As a further note, the above biomass calculations do not include any merchantable forest biomass, thus they exclude the hardwood surplus discussed by Henry (1981, 1982) above.

The 1984 Royal Commission on Forestry report tended to dismiss the issue of fuelwood from the forest. The report stated that Nova Scotia has a gross surplus of hardwood, because only about one third of the annual allowable cut (AAC) of 1.24 million m^3 (600,000 cords) is used for industrial purposes. It is uncertain what use is made of the

remainder, although some is consumed in the domestic fuelwood market. There is a limited opportunity for the disposal of fireplace logs at favourable prices in urban centres, but "in a technical sense, wood is not an efficient source of energy, and its use has to be justified by a low price which, at present, hardly meets the cost of extraction and delivery". The Commission concluded "It is, perhaps, only as a by-product of other forest or industrial activities that fuelwood can be justified as a source of industrial energy."

In 1984, the Nova Scotia Forest Products Association released a study that stated the potential supply of residue wood for fuel from conventional logging operations alone is 980 oven dry kilotonnes annually, equivalent to 490 million litres of fuel oil a year (1986 value of $138 million at current prices). A survey of publicly owned institutions in Nova Scotia showed the Province required over 106 million litres of fuel oil annually, at a cost of $24 million ($30 million at current prices). For every million litres of fuel oil replaced with wood there is an estimated $45,000 net gain in the province's gross domestic product, an increase in labour income of $88,000 and an additional 4.65 person years of employment generated.

One major barrier to the development of a market for wood chips has been the lack of guarantee of supply. To this end a consortium of approximately 40 associate sawmill operators was formed in 1985 to ensure a reliable source of wood chips for industries and institutions wishing to utilize the home-grown energy source.

Wood chips represent a previously unutilized energy source - tree chips from areas devastated by spruce budworm, as well as chips from logging slash and hardwood left behind during softwood processing can be used. In addition to providing energy, chipping operations will provide a higher return from woodlots and leave the land in better condition for planting. There are, however, two potential disadvantages:

1. The use of intensive harvest techniques will be accompanied by much larger increases in the removals of nutrients, due to the fact that relatively nutrient rich tissues such as foliage, twigs and small branches are also removed from the site. Thus, the short-term biomass gains are purchased at the longer-term expense of accelerated nutrient removals. (Freedman, 1982).

   Intensive, agroforestry types of site management (short-term rotation) must be accompanied by fertilization to restore nutrients and to allow sustained high yields. On the other hand, calculations relevant to longer length rotations indicate more modest removals of nutrients with harvested biomass (ibid.).

2. Landowners may be tempted to harvest immature stands for quick cash, foregoing higher yields in the future.

In May, 1987, the Select Committee of the Nova Scotia House of Assembly on Energy from Wood Biomass released their report. One of the central recommendations was the

increased use of wood chips (waste from wood operations), for energy. While the cost of oil has fallen, the cost of producing energy from woodchips is still only about one third of that incurred in burning oil (Chronicle-Herald. March 11, 1986). A number of industries in the Province already use wood chips as an energy source.

The Committee stated the use of woodchips and other forest biomass is an alternative energy source that shows great potential. They concluded Nova Scotia can provide an equivalent of 2.5 million cords of wood for energy production, with an energy content equal to almost 7 million barrels of oil. The cash value of substituting woodchips for oil could save the Province $100 million at current oil prices. An estimated 6,500 new jobs could be created in direct harvesting and related service industries.

There are however, a number of factors which must be further examined before any viable woodchip operation can be established. They include: identification of markets, guarantee of supply, marketing, delivery and price, and the environmental impact on forest soil nutrient levels of using forest biomass, scrub and waste for woodchips.

Until now, the increase in wood fibre consumption has been slow because of several factors: high capital cost, wood fibre systems require greater management input, and uncertainty of economic factors in changing over from oil to wood fibres. To these ends, private owners may require various forms of assistance and incentives.

As a general observation, the Committee urged Government and the private sector to proceed with research projects, and not be influenced by a false sense of security because of recent drops in foreign oil prices. They stressed the long–term view that oil is a non–renewable resource, with 70 percent of this source in the Middle East and vulnerable to unstable conditions. Such factors as energy conservation and import substitution should be given priority.

The case of biomass use in Sweden offers some guidance for Nova Scotia. Sweden does not have domestic supplies of coal, oil, or natural gas. The country does have substantial resources of hydroelectric power, forest biomass, and peat. There are more than a dozen nuclear power plants, supplying 50 percent of the current electrical supply, but a recent plebiscite confirmed the public decision to phase out all nuclear plants by 1994 (Nova Scotia, 1987).

Only 2 percent of Sweden's electricial energy comes from forest biomass, peat, and garbage combustion. The goal is to increase this to 10 percent. It is estimated that for every 1,000 tonnes of green wood chips used to displace oil, one person-year of employment will be created in the chip industry. As a further note, in Sweden only the poorest quality wood fibre and tops and branches are used for wood chips; better quality wood is sorted and used for products yielding a higher economic return (ibid.).

In Sweden, district heating is very common: more than half of Sweden's municipalities and cities are served by district heating networks, using hot water as the heating medium. This widespread use of district heating is a result of the Swedish government's decision to reduce the country's dependence on imported energy. Most systems are municipally owned, non-profit utilities and are integrated with one or more large industrial users. The district heating networks include consumers as small as individual family residences (ibid.).

The Nova Scotia Select Committee on Forestry concluded that while it was difficult to envision city wide district networks in Nova Scotia in the foreseeable future, they felt that opportunities for district heating in selected areas exist and should be pursued if economically viable.

7 Towards a Residential Fuelwood Monitoring Program

A number of studies of residential woodfuel use in Nova Scotia have indicated that its use is increasing, after a period of fairly major decline in the mid-1960's (Report on the Increased Use of Wood as an Energy Source in Nova Scotia 1982; Blair and Hanson 1981;1982). As well, data from the Canada Oil Substitution Program (COSP), shows that during the term of the program (1980-1985), over thirty-five thousand residential units in Nova Scotia, were converted from oil, 91% of these to wood (Energy, Mines and Resources, pers. comm.). Surveys of households (Blair and Hanson 1981;1982; Gray and Blair 1985) show significant use of residential fuelwood, particularly in rural areas. Data from Statistics Canada show the number of single dwellings in the Province using wood as a principal fuel has risen from twelve thousand in 1978 to forty-five thousand in 1985 (from 7% to 19%), and the number of dwellings with wood as a supplementary fuel has risen from thirty-seven thousand in 1979 to fifty-five thousand in 1986 (15% to 18%). It is important then, in terms of policy planning and resource management, to have accurate and up-to-date quantitative data on the supply of and demand for wood for residential fuel use in the Province. It is also important to have a program for gathering these data which is comprehensive and consistent, and thus allows for development of a time series. To date, no such program has been implemented. In this context, the School for Resource and Environmental Studies (SRES) has developed a methodology for a residential woodfuel monitoring program for Nova Scotia. The considerations that must be taken into account in the design and implementation of such a monitoring program are outlined herein, including both past producer's and consumer's surveys, and the methodology and design used.

Past Woodlot and Fuelwood Surveys:

A number of surveys have been undertaken in Nova Scotia, both of producers and consumers of woodfuel. In the following section the methodologies of these surveys (including one from Newfoundland) are briefly outlined to give an understanding of the problems and prospects in conducting such a comprehensive survey, as in the monitoring program proposed in this paper.

A. Producers:

The Nova Scotia Private Woodlot Owner Survey (MacQuarrie, 1981)

This survey relied on the 1974 data base of property information then available for Nova Scotia. The list contained names and addresses of the owners who were assessed for 10 acres or more of forest land - a total of 48,979 parcels of forest land, with an assessed area of 5,283,000 acres.

Overall, the sampling intensity was 1 in 10. Three mailings were sent to those owners selected: an introductory letter, an explanatory letter and questionnaire, and two weeks later a reminder letter and a copy of the questionnaire. This resulted in an overall response rate of 58% of correct addresses. Unfortunately, 18% had "incorrect" addresses.

A Survey of Urban Fuelwood Dealers in Halifax-Dartmouth (Murphy, Hanson and Blair, I.R.E.S. 1981)

Fuelwood dealers in the Halifax/Dartmouth area were identified from newspaper classified ads, ads in woodstove stores and through contacts with woodlot owners. A list of 82 vendors was compiled.

Telephone interviews were conducted. An attempt was made to contact all 82 potential respondents. Forty-three interviews with dealers who had recently sold wood were completed. An additional 6 respondents refused outright. Of the remaining 33 possible dealers, nearly all of whom had advertised wood for sale during the previous 12 months, 4 had sold only a small amount of wood, 10 had sold no wood, and 19 proved impossible to contact.

Respondents were surveyed on a variety of topics - including volume of sales, turnover, occupational pluralism, supply sources, diversity of products, equipment and labour, capital investment and opinions on marketing.

B. Residential Consumers:

Fuelwood Consumption in Newfoundland (Northland Associates Ltd., 1979)

This survey was conducted as an ENFOR project (P-2) to determine residential woodfuel use in Newfoundland in 1977-78, with a comparison estimate for 1978-79.

The original survey method involved telephone interviews, followed by more detailed personal interviews with householders. This was later changed to a more detailed telephone interview survey only, as the process of visiting homes was very "time-consuming". Phone calls were made "in the field". The authors note that the "householders felt more relaxed and cooperative in the telephone interview".

A "cluster sampling" methodology was used. Towns thought to have similar consumption rates within a forestry unit were grouped into divisions. Each community within a division was assigned a number and then a random selection of towns was made. Larger towns within a management unit were automatically included. An attempt was then made to contact at least 40 households in each community.

The households were chosen from the most recent telephone directories. Names of households were numbered consecutively and chosen randomly using random number tables. In larger towns, pages of the directories were chosen randomly and names were selected from the pages systematically.

A total of 1,329 phone calls were made, resulting in 1,088 contacts (a response rate of 82%). The results were weighted to provide estimates of fuelwood use for Newfoundland.

Usually, cluster samples will be less efficient (i.e., will yield greater sampling errors) than simple random samples of the same size. However, it may cost considerably less to obtain cluster samples, as surveying is concentrated in certain geographic areas (Blalock 1960).

A Survey of Residential Woodfuel Use in Rural Colchester County (Gray and Blair, I.R.E.S. 1985)

This survey was undertaken in January, 1984, for the purpose of determining the nature and extent of woodfuel use by rural residents in Nova Scotia.

The survey was conducted as a telephone survey. The sample was chosen systematically using the latest telephone directory. Two hundred and eighty-one phone calls were made, resulting in 200 respondents - a response rate of 71%. Only rural areas (<1,000 population) were surveyed. The total percentage of respondents burning wood was 72% - 52% as a primary source. Few households (2%) burnt wood for recreation.

This questionnaire was not as detailed as in the urban and small town surveys. Data were gathered on dwelling type, heating sources, wood fuel burning devices, amount of wood burnt, wood supply and general comments.

Fuelwood Use in Two Nova Scotia Communities: Yarmouth and Middleton (Blair and Hanson, I.R.E.S.,1982)

This survey was conducted as a mail survey. One hundred and fifty questionnaires were sent to residents in Yarmouth and 100 to residents in Middleton. The sample was randomly selected from the 1981 telephone directory.

The response rate from the two communities were almost identical: 64% in Yarmouth and 68% in Middleton.

Forty-four percent of the Yarmouth respondents reported burning wood, while 46% of the Middleton respondents did so.

The questionnaire requested information on dwelling type, wood burning amounts, type of wood burnt, preferred form of buying wood, and supply and marketing.

A Survey of Fuelwood Consumers in Halifax/Dartmouth Nova Scotia (Blair and Hanson, I.R.E.S.,1981)

The questionnaire was mailed with an accompanying letter and a postage-paid return addressed envelope,. to a sample of 2,000, consisting of two sub-samples of 1,000 each. The first was randomly selected from houses in Halifax/Dartmouth. The second was randomly selected from certain wards, chosen as representative of different ages and sizes of housing stock. The population list used for sampling was the 1981 Might Directory, a directory listing all the street names in Halifax/Dartmouth, with an address for each dwelling. Names were not selected for dwellings with more than 3 units, nor were businesses.

No significant differences were found between the respondents to the two samples. The report includes only the entire metro sample, except where the ward sample respondents were used for comparative purposes.

The overall response rate was 44% for the metro wide sample. Thirty-eight percent of respondents reported burning wood for fuel (mostly in fireplaces only).

The questionnaire was fairly detailed, requesting information on dwelling type, amounts of wood burnt, type of wood burnt, preferred form of buying wood, and supply and marketing.

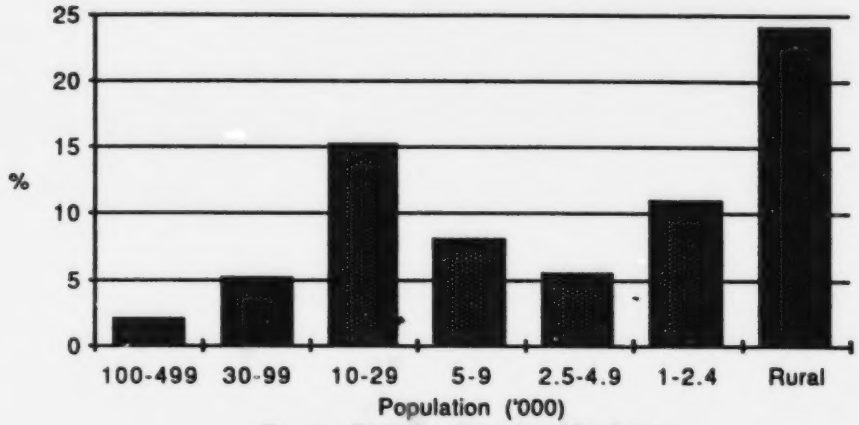
As reflected in the surveys above, there are, of course, two main groups concerned with residential woodfuel use: (1) consumers and (2) producers. These groups are not necessarily mutually exclusive. This is especially true in Nova Scotia, where over 50 percent of the forest land is in private ownership of less than 400 hectares (The Trees Around Us 1980), and where many rural residents own their own woodlot. In Colchester County, for example, 31% of the wood used came from respondents' own woodlots.

In terms of consumers, or users, of woodfuel, three main categories, based on geographical classification, are apparent: (1) urban users (Halifax/Dartmouth and Sydney areas), (2) small town consumers (e.g. Middleton, Truro and Bridgewater) and (3) rural (population < 1,000) users (both farm and non-farm unincorporated areas). These three categories of consumers differ from each other on a number of dimensions of woodfuel use, which should be taken into account in designing a monitoring program for residential consumption. This is especially apparent in comparing rural and urban burners. For example, urban residents are less likely to use wood as a fuel (although its use may be growing) and their supply of wood usually comes from a different geographical area. Urban users report a high rate of burning woodfuel for recreation (39%) versus only 5% for rural users. Urban users usually buy their wood from a dealer, whereas rural users are more likely to own a woodlot and cut their own, or else obtain the wood from a relative. Rural consumers are the heaviest residential users of wood for fuel (Gray and Blair, 1983). There are thus different patterns of use between these three groups, and different patterns of supply.

Figure 2 illustrates data from the 1981 Canadian census which confirm the above conclusions. Types of principal heating fuels were categorized as oil or kerosene, piped or bottled gas, electricity or "other". The latter category would presumably mostly be wood (with a small percentage coal or solar). A breakdown of "other" is not given for this census data, but supplementary data from Statistics Canada indicates that at least 71% of this category is accounted for by wood. Figure 2 shows the percentage of owned dwellings in each population category using "other" as a heating fuel source.

Figure 2 Per Cent Dwellings with Principal Heating Fuel as "Other"

Nova Scotia - 1981 - Owned Dwellings



Source: Statistics Canada 1981 Census

Census data of this type cannot be used to produce an accurate quantitative estimate of fuelwood consumption however, as no data were collected on the amount of wood burnt by each household. This could vary, due to the variable efficiency of woodfuel devices, and the degree of use. As well, while the heating source is classified as "principal", this still allows for a variation in the percentage of woodfuel used, in the principal, as opposed to any supplementary heating system. For example, the amount of wood burnt by a household with wood as a principal fuel and oil as a supplementary fuel would differ from that of a household with wood as a principal fuel only, and no supplementary system.

Towards a Monitoring Survey Strategy

Any monitoring program of residential woodfuel use must have a number of basic characteristics:

- the program should be thorough and cover all significant categories of woodfuel supply and demand for residential use
- the program should be of comparatively low cost and be relatively easy to implement, so that the program could be repeated on a regular basis to detect any shifts in demand and supply over time
- finally, the program should provide quantitative answers to a number of central questions:

- how much woodfuel is bought and sold in a given year
- where the consumers of woodfuel are located (use by area)
- what are the significant demographic factors determining woodfuel use (rural/urban, income levels, etc.)
- where do consumers obtain their woodfuel (buy/cut, dealers/own woodlot/relatives), and
- what are the barriers to woodfuel use (supply shortages, costs, etc.).

There are a number of possible sources of data which could be used in any residential woodfuel monitoring program. Woodlot owners' associations are one possible source of information on the present state of woodfuel supply and the problems and opportunities that the owners face. Data such as these would be important in providing the context of woodfuel use on the supply side. Perhaps the most important sources are the consumers and producers (woodlot owners) themselves. Information from these populations could probably best be obtained by means of surveys based on random samples.

A survey should be the central component of a woodfuel use monitoring program. There are a number of considerations to be taken into account in developing the methodology, however. The most basic question is, which population should be surveyed. A survey of woodlot owners (producers) might be the easiest to carry out. The owners of woodlots could be identified from the Department of Municipal Affairs taxation list. Owners of bona fide forest land are identified and taxed at a rate of $ 0.25 an acre, otherwise the woodland is classed as e.g., cottage land or land for development, and taxed at the ad valorem tax rate. The main problem here might be any subjective biases of the assessors classifying such land. Such a list would identify owners of both small and large woodlots, which is important, as the majority (73%) of the forested land in Nova Scotia is privately owned, with 52% in holdings less than 400 ha (The Trees Around Us 1980). The data from this survey would provide information on the geographical location of producers, how much wood they sold, what kind of wood (maple, birch, etc.), at what price and in what form. It would also, of course, provide an answer as to how much was burnt by the producers themselves, as well as an estimate of woodfuel given away to friends or relatives. What it would not provide is any estimate of unmet demand on the part of consumers (although this may be very low, especially in rural areas - see Gray and Blair 1985). As well, it would yield no information on woodfuel use on a household basis such as numbers burning wood, and amount per household. In short, a survey of producers would not provide any information on consumers other than the amount, form and price of wood sold to them for their use. As well, any wood obtained other than from private woodlots (e.g. Crown land, roadside clearance) would not be identified.

A survey of residential woodfuel consumers would appear to be the most comprehensive and satisfactory method of monitoring residential woodfuel consumption. The main difficulty is the inability to identify the target sub-population of woodfuel users, as distinct from the general population, before surveying them. Thus, all households in the province would have to form the population from which the sample

was selected. This would not be a major difficulty, as a sample could be drawn from the computerized assessment data base of the Department of Municipal Affairs. This data base contains information on the number of units in the dwelling, and apartment buildings could thus be excluded. A survey of consumers would provide information that the producers survey would not: the types of appliances in which woodfuel was burned (and changes over time), information on unmet demand for woodfuel, difficulty in maintenance of supply, and average woodfuel use over the past years. The consumer survey would also provide information on the amount of wood obtained by consumers that was not purchased from woodlot owners.

One possible source of data on residential woodfuel consumption patterns is provided by the data from the annual Household Facilities and Equipment Survey, conducted by Statistics Canada. Data are presented for the principal heating fuel for single dwellings (single detached, single attached and mobile homes). A separate category for wood is given. A graphical presentation of the trends for the major fuel types is presented in Figure 3.

Figure 3 Principal Heating Fuel - Single Dwellings

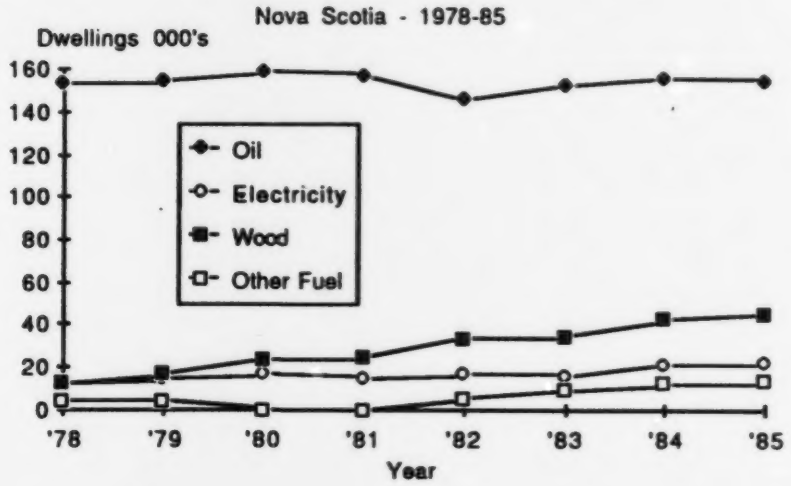
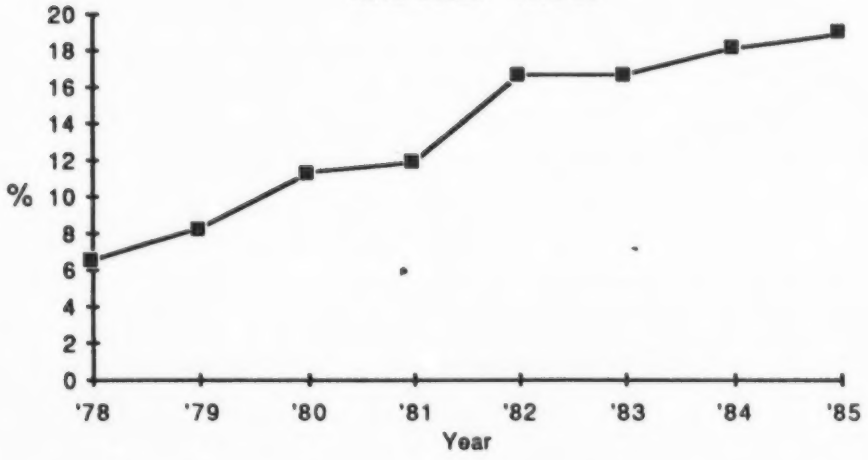


Figure 4 illustrates the percentage of the total single dwellings using wood for fuel in Nova Scotia, 1978-85.

Figure 4 Wood as Principal Heating Fuel
Percent of Total Single Dwellings
Nova Scotia - 1978-85



These data would provide a useful check on the validity of any residential fuelwood survey, and would serve as an adjunct source for any monitoring program. As well, similar data are available for wood as a supplementary fuel source, although this is for both single and multiple units. As is the case with census data, however, such data provide no details of household woodfuel use (types of wood, sources , prices, etc.) which only a detailed consumers' survey would provide.

There are a number of general considerations in regard to any survey undertaken as part of a monitoring program. The first is the form the survey should take: personal interview, telephone or mail survey. The first option (personal) should probably be ruled out due to the cost involved in conducting personal interviews for a sample that is distributed over the entire province. A telephone interview (as for a personal interview) would guarantee a fairly high response rate. Although field costs would be reduced, there would still be interviewer costs and the addition of long-distance charges. Also, a telephone survey would exclude all those who did not have a listed phone number (new residents, those without phones or unlisted numbers). The proportion of these households would probably be low enough so that their absence would not bias the results substantially. A mail survey would cost less in terms of telephone costs and interviewer time. It would however, probably result in a lower response rate. This response rate could be raised by follow-up mailings, or phone calls. A recommended solution is a combination mailing (with a mail follow-up) and then a phone follow-up to any remaining non-respondents. This procedure is recommended by Marsinko et al.

(1984), who obtained a response rate of 82% in a survey of wood fuel consumers in South Carolina.

Whatever the details of the survey and questionnaire design, it is very important to ensure a very good response rate. A response rate of 50 percent is adequate for analysis and reporting. A response rate of at least 60 percent is good and one of 70 percent is very good (Babbie, 1973, pp. 165). A response rate of at least 70% is the minimum response rate required before one can generalize, with confidence, from the sample responses to the entire population (i.e. ignore the possible response bias). This generalization, or weighting, would be an integral part of a survey of woodfuel residential consumers or producers. Weighting would provide an estimate, using the following formula, of the total amount of wood bought or sold in the Province (or forestry sub-division).

Total amount of wood consumed =

total number of households in population x proportion burning wood x average consumption

(The latter two figures would be obtained from the consumers' survey.)

This process would be repeated for each forestry sub-division and summed for the total province, using household census data. If the response rate is 70% or more, one can safely assume that those who did not respond are similar to those who did respond, on the surveyed dimensions. This is particularly important in surveys such as these where the respondents can fall into one of two possible categories (in the case of consumers, those who burned or did not burn wood, and in the case of producers, those who sold/did not sell wood), where the details of the survey are not applicable to one of the two sample groups. With a relatively low response rate, one could not dismiss the possible response bias (towards burners/producers) generated by the tendency of those who might feel the survey did not apply to them (non-burners, non-producers) to be less likely to return the questionnaire. This bias would result in an overestimation of woodfuel production and consumption. This bias was confirmed by Marsinko et al., 1984) where 46% of the respondents to the initial mail survey used firewood, but only 36% of the respondents to the follow–up telephone survey of non-respondents used firewood. Even if a respondent will not fill out the questionnaire, it is important to find out if they did or did not burn wood. Thus, it is important to include a mail follow-up and a further telephone follow-up, to non–respondents.

A further note of caution should be made. While the term "cord" has a standard definition (128 ft^3 or 3.623 m^3) that is widely accepted, there are other measures that may be confused with it, such as "long cord" or "face cord". As well, the measure of a pick-up truck full of wood is sometimes considered as a cord (Marsinko et al.,1984). There is some evidence that wood consumption estimates obtained from surveys may be somewhat inflated, as the other terms used are smaller than a standard cord. To reduce this error, respondents should be asked to explicitly define their use of the term "cord" on

on the questionnaire. These responses would then be translated into the standard cord unit before data analysis.

Both the producers and the consumers survey should take the form of a stratified random sample. A random sample ensures that every member of the population has an equal chance of being chosen. A stratified sample ensures that all sub-populations are sampled. The basic principle of a stratified sample is quite simple. The population is divided into strata, such that the differences within a stratum are less than those between strata, on one or more relevant dimensions (e.g. woodfuel use). Strata might be developed on a geographical basis (the eight forestry sub-divisions), or woodlot size, or both (different lot size groupings within each stratum). The latter would probably be the best technique to use in the case of woodlot owners. In the case of consumers, a geographical basis (such as the eight forestry sub-divisions in Nova Scotia and the population groupings within these sub-divisions) would probably be sufficient, although the inclusion of the variable of population size may be important, due to varying patterns of woodfuel use in various sized communities (see below).

A random sample is taken from each stratum. Stratification reduces the possibility of one type of sampling error, that error due to differences between strata. This technique is particularly valuable if the sample size is relatively small. The use of stratification would probably allow the use of a sample size of 575. Assuming a response rate of 70 percent, this would allow for 400 returns, the minimum needed to ensure a 95 percent confidence interval. (In practice, a sample size of closer to 1,000 should be chosen, to provide a higher confidence level for results from the individual strata.) It would be better to have a relatively small sample, over which one could have more control and ensure a high response rate; than a large sample, with a poor response rate.

It is important to include the population size of the community as a key variable, as S.R.E.S. surveys (Blair and Hanson, 1981,1982; Gray and Blair, 1985) and Statistics Canada data have shown distinct different use patterns between urban and rural households. The varying percentages of use and reasons for burning are illustrated in Figure 1 (page 15). While it may be more difficult to stratify the sample on this dimension, such a sample would yield results which could be weighted to the varying household totals for each population area.

Whichever stratification system is used, it is important that the strata be mutually exclusive and exhaustive. That is, a respondent can be in one, and only one, stratum, and each and every member of the population would fall into a stratum. For either consumers or producers, the sample would be drawn from all possible members (all all households/woodlot owners in Nova Scotia). As shown in Table 1, the results of the 1981 IRES survey of woodlot owners indicates that no area (with the possible exception of sub-division 7) is insignificant in terms of woodfuel production in the Province. As well, excluding any area or group, a priori, would raise the possibility of missing

increases in woodfuel production or consumption that might occur in that group or area over time.

Table 1 Woodlot Owners - Cords of Wood Sold and Burned - 1980

Forestry Subdiv.	Counties	Cords Sold	Cords Burned[1]	Total	Percent
3	Halifax, Hants	32,911	14,559	47,470	24.9
2	Colchester Cumberland	16,055	18,267	34,322	18.0
4	Annapolis, Kings	15,359	14,100	29,459	15.5
5	Lunenburg, Queens	12,177	10,136	22,313	11.7
6	Shelburne, Yarmouth, Digby	10,086	9,616	19,702	10.3
1	Pictou, Antigonish, Guysborough	8,821	8,923	17,744	9.3
8	Cape Breton, Richmond	2,449	11,376	13,825	7.2
7	Inverness, Victoria	2,183	3,732	5,915	3.1
	All Counties	**100,041**	**90,709**	**190,750**	**100.0**

Source: I.R.E.S. Woodlot Owners' Survey, 1981

[1] Wood burned by the woodlot owners themselves

Recommendations for a Monitoring Program

- A variety of sources point to a significant increase in the use of wood for residential fuel in Nova Scotia during the past eight years. It is important then, in terms of policy planning and resource management, to have accurate and up–to–date quantitative data on the supply of and demand for wood for residential fuel use in the Province. It is also important to have a program for gathering these data which is comprehensive and consistent, and thus allows for development of a time series. To date, no such program has been implemented. In this context, the School for Resource and Environmental Studies (SRES) has developed a methodology for a residential woodfuel monitoring program for Nova Scotia.

  A stratified random sample of single dwellings in Nova Scotia should be surveyed on their use of wood for fuel. At a minimum, the sample should be stratified on the basis of forestry sub-divisions. If feasible, sôme stratification on the basis of urban/rural division should be attempted, as fuelwood use has been found to be more widespread, and more intensively used, in rural as opposed to urban areas.

  The questionnaire would be similar in design to those used in the small-town and urban woodfuel surveys conducted by IRES. The amount of fuel burnt (now and in the past five years), types of wood burning equipment, primary/secondary fuels, types of wood used, sources of woodfuel and difficulties in maintaining supply are all key variables. As these questionnaire formats have been used in past surveys, the need for a pre-test would be eliminated.

  The results from the survey could be weighted (using Canada census data) to provide estimates of the total amounts of woodfuel consumed, in each sub-division, and in the Province as a whole. To avoid non-response bias in this estimate, it is important to ensure a response rate of 70% or more. Recent reports indicate this can be achieved by using both mail and phone follow-ups. It is better to have a relatively small sample with a high response rate, than a large sample with a poor response. To further ensure an accurate weighting process, the results from the annual survey of Household Equipment and Facilities (Statistics Canada) could be used as an overall control on the total estimate of households burning wood.

  An important consideration in any long–term monitoring designed to establish a time series, is the frequency with which to conduct the survey. Any such monitoring program must detect and monitor significant increases in woodfuel use. One variable affecting use is clearly the price of home heating oil. Any substantial increase in this price would likely increase the use of wood for fuel. Another important factor would be the introduction of any government incentive program (such as COSP) that provides an additional economic incentive for conversion from oil. Data from the Statistics Canada Household Facilities Survey provide a general indication of any such increase, or decrease, in woodfuel use. In the absence of any significant change in use patterns, the survey should be conducted every five uears.

The data from a household (consumers) survey, should provide an adequate data base from which to estimate the amount of residential woodfuel consumption for the entire province, as well as any subdivision, and to identify any changes in these patterns over time. This information would prove very valuable in evaluation of existing policies, or formulating new management policies, for residential woodfuel use in Nova Scotia.

8 Conclusions and Recommendations

Although dependence has lessened, Nova Scotia still depends on imported oil; forty-three percent of the electrical generating capacity comes from oil burning units, down from 65% in 1979, due mainly to the increasing use of coal (40% in 1984). Oil is used as the principal fuel in 68% of dwellings, down from 85% in 1979. Wood is the principal source for 15%, providing 18% of the residential energy requirements. Under the COSP program, 32 thousand units were converted from oil to wood, from 1980-85. Surveys by Statistics Canada show that for single dwellings, the use of wood has risen from 12 thousand in 1978 to 45 thousand in 1985 (from 7% to 19%). In 1985, 55 thousand dwellings (18%) used wood as a **supplementary** heating source, up from 37 thousand (15%) in 1979. It is clear that the residential use of wood is substantial, especially in rural areas, where there is relatively easy access to woodlots and wood is cheaper; the 1984 survey of rural Colchester County showed 75% of households burnt wood for fuel. In the principal urban area of Halifax/Dartmouth, such woodfuel distributors as Goodwood Fuel Company, have been established in recent years, allowing for a more stable supply. As well, many residential users have switched to more efficient types of wood burners, e.g. air-tight stoves replacing fireplaces.

There is a good deal of room for improvement in the efficiency of wood burning applicances. Many conversions to date have involved applicances that could be rated in the range poor to pitiful. In a recent test conducted by Energy, Mines and Resources Canada, of 10 central wood heating applicances, efficiency of the best, average, and worst was 64, 52, and 45 percent respectively. With a small amount of 'R&D' the best furnace was modified to achieve 79 percent efficiency (Ed Hogan, Energy, Mines and Resources, pers. comm.) If applicance efficiency could be doubled, biomass could provide almost all the space heating required in the Province.

The 1984 Royal Commission on Forestry report tended to dismiss wood as a fuel source, stating "in a technical sense, wood is not an efficient source of energy" and its use has to be justified by a low price. The Commission, concluded that "it is, perhaps, only as a by-product of other forest or industrial activities, that fuelwood can be justified as a source of industrial energy." There was no discussion of residential use. This position ignored a number of factors, not least of which is the significant increase in

residential woodfuel use in recent years, resulting in an established and wide-spread use of fuelwood, particularly in rural areas. As well, the benefits of the substitution of fuelwood, a renewable resource produced in the Province, for imported oil, are an important consideration.

The Nova Scotia House of Assembly Select Committee on Forestry: Woodchip and Biomass, in their final report, while placing a primary emphasis on biomass energy from wood wastes of existing forestry operations, did not dismiss the residential use of woodfuel. The Committee recognized that "residential wood burning continues to be an important component of the total volume of wood burned in the province." (Committee Report, pg. 18). They went on to point out that:

> "...between 250,000 and 350,000 cords of wood are also burned by homeowners and other small energy users. Exact statistics for roundwood consumption in Nova Scotia are not available because of the large number of suppliers of the wood, the large numbers of people who produce wood for personal use from their own woodlots and the large number of users." (Committee Report, pg. 18)

While the topic of residential fuelwood use was not considered as such, the Committee stressed that Government and the private sector should not be influenced by the recent drop in oil prices, but should rather give priority to the long-term goals of energy conservation and import substitution.

From 1981 to 1985, residential fuel oil prices rose from $0.19 to $0.382 per litre. Fuel oil prices began falling in February, 1986. Since that time there have been a number of drops in price, with the current (July, 1987) price at $0.273 per litre. While these changes would certainly affect the values calculated in Henry's 1981 study, it should be noted that the current price is well above 1981 levels. As well, at any time the instability of geo-political factors affecting world oil supply could lead to another round of increases. There is still significant economic benefit to be derived from the use of the harvestable surplus of hardwood.

A possible constraint on the future increased use of hardwood for fuel is the pressure to convert hardwood sites into softwood. Increased use of wood for fuel can lead to competition with the pulp and paper or lumber industries. The pulpwood industry is well established in Nova Scotia, and the average allowable cut of softwood is being exceeded by 10-20%. Large areas of softwood have been lost to the budworm in Cape Breton, and conversion may be necessary to maintain supply. Hardwood fuel is often a side product of mixed forest harvesting. This resource may slowly disappear in the long-term, due to clearcutting and reforestation, which may lead to a predominately coniferous forest (Eaton et al., 1986, p. 144).

There is an impetus toward the use of wood waste biomass for energy in Nova Scotia. This is in large part due to the developmental potential of this energy source, and recent

publicity. Residential wood fuel use has already gone through a phase of expansion, but demand still appears high. While the potential economic benefits of the use of wood biomass are important, the already substantial residential use of wood fuel should not be neglected. Consumers have made considerable investments in the use of woodfuel, in many cases. Furthermore, it appears that such use could be increased as a complement to forest biomass use for industrial energy, by harvesting the surplus merchantable hardwood available. Thus, growth of both sectors could increase simultaneously.

Many of the barriers to increased use of the surplus forest biomass in Nova Scotia are institutional, not strictly economic. These factors have been considered in the SRES reports outlined previously: the need for better marketing, stability of supply and better woodlot management, in the context of a Province with 30,000 independent woodlot owners, many with small holdings. At the same time, environmental impacts such as the nutrient losses resulting from whole tree harvesting, and wildlife habitat changes must be considered. To this end, the monitoring of long-term environmental impacts of intensive forest management should be given prority.

Further research is needed in the area of the potential impact of increased forest waste biomass use, on the supply of hardwood for residential woodfuel. In particular, such effects as conversion of hardwood sites into softwood need to be considered. What are the potential socio-economic costs and benefits of increased biomass waste use versus hardwood woodfuel use, to both the producers and consumers of residential woodfuel?

A comprehensive monitoring program of residential woodfuel use in Nova Scotia is needed. This program should be established to develop a time-series of data on the number of households burning wood as a primary and supplemental fuel source in each major forestry sub-area, as well as detailed data on sources of supply and types of woodburning equipment used, and amount of fuel consumed.

It is clear that residential woodfuel use has increased substantially in recent years, and may continue to do so if oil prices rise to former levels. This woodfuel use has clear economic benefits for Nova Scotia, and it is thus important to have accurate and current data in order to effectively plan for the future management of Nova Scotia's forests. This is especially true in light of the increasing emphasis on more intensive forest management. It is difficult and inefficient to plan for the future if one does not have an adequate knowledge of the present and past.

In a number of the SRES surveys of residential woodfuel use, particularly in urban areas, users identified problems with the stability of supply. Urban residents do not have easy access to private woodlots, as do many rural households; the former are obviously more dependent on retail dealers. While the supply problem has stabilized to some extent, it appears, in recent years, this situation should be monitored closely. Unmet demand by these residents has economic costs for both potential buyers and sellers.

There is also a potential for conflict between residential woodfuel users and industrial users if more extensive use of woodfuel was promoted by governments. A monitoring program would permit responsible agencies to take appropraite action at a policy and program level to minimize the economic costs borne by suppliers, homeowners or industries.

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